

THE TADPOLE OF *LITORIA PHYLLOCHROA* (ANURA: HYLIDAE)

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The tadpole of *Litoria phyllochroa* is described and illustrated from East Gippsland, Victoria. Breeding site characteristics are given for a variety of habitat types. Characteristics distinguishing tadpoles of this species from tadpoles of sympatric *Litoria* species are presented.

LITORIA PHYLLOCHROA (Gunther, 1863) is a small (27–41 mm long; Tyler 1992) green hylid frog found along the coast and hinterland of southern Queensland, New South Wales and eastern Victoria (Brook 1983, Tyler 1992). There is long-standing recognition that two species are presently included under the name *L. phyllochroa*; this paper deals with *L. phyllochroa* Form A of Littlejohn (1967). In Victoria its distribution is generally east and south of the Great Dividing Range (Hero et al. 1991), although some populations occur as far north as the Mitta Mitta area (Atlas of Victorian Wildlife Database, Department of Conservation and Environment Victoria).

Litoria phyllochroa is a member of the *Litoria citropa* species group of Tyler & Davies (1978, 1985), which also comprises *L. subglandulosa*, *L. pearsoniana* and *L. piperata*. *L. phyllochroa* is morphologically most similar to *L. pearsoniana* from which it can be distinguished by the presence of a green tympanum rather than a brown one (McDonald & Davies 1990). *L. citropa* and *L. phyllochroa* are the only members of this species group currently recognised as occurring in Victoria. A possible addition to this species group is *Litoria spenceri*, which was suggested by Copland (1957) to be related to *L. citropa*. These two species have very similar biphasic advertisement calls (Watson et al. 1991) and similar life histories (personal observation). The tadpole of *L. spenceri* is also morphologically very similar to that of *L. phyllochroa* (Hero et al. in prep.).

Litoria phyllochroa, *L. piperata* and *L. spenceri* are the only species of this group for which the tadpoles have not been described. We present a diagnosis and description of the tadpole of *L. phyllochroa* from Victoria, indicating features which distinguish it from sympatric lotic hylid species and from other species in the *L. citropa*

group, and the habitats where it was found in eastern Victoria.

METHODS

Tadpoles were collected in the summers of 1989/1990, 1990/1991 and 1991/1992 at several locations in Central and East Gippsland (Fig. 1, Table 1). At each collection site the location of tadpoles in the stream, the micro-habitat, the presence of other tadpole species and the presence of fish were noted. A brief description of

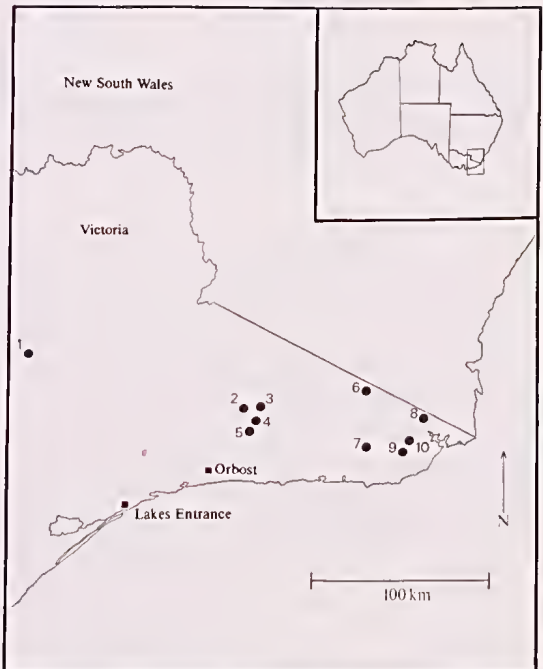


Fig. 1. Sites at which *Litoria phyllochroa* tadpoles were collected. Locality numbers refer to Table 1.

Date	Location & Aust. Map Grid	Micro-habitat	Museum Reg. No.	BL mm	TL mm	Gosner Stage	Water °C	Sympatric Species
21/12/89	Wongungarra R. 8323/004921 (1)	CBW	D61730	5.7	14.8	29	19	<i>L. lesueuri</i>
			"	5.1	12.9	28		
			"	5.5	13.0	29		
			"	4.9	12.7	25		
		FS					13	
18/01/90	Wongungarra R. 8323/004921 (1) 8323/005920 (1)	CBW	Not Collected				22	<i>L. lesueuri</i>
		IBW	Not Collected				30	<i>L. lesueuri</i>
		ISP	Not Collected					
20/2/90	Wongungarra R. 8323/010938 (1)	CSP	D61728	11.5		42	19.5	
			"	11.9	31.6	40		
			"	12.5	32.4	41		
			"	12.0		42		
			"	12.6		42		
			"	13.6		42		
		"	13.2			42		
22/2/90	Wongungarra R. 8323/004921 (1)	CBW	D61727	11.8	31.3	37	19.5	<i>L. lesueuri</i>
			D61726	11.6		46		
			"	9.9		46		
			D61729	12.5	30.2	37		
			"	12.5	30.0	37		
			"	11.0	25.6	42		
			"	12.3	29.2	38		
			"	12.2	29.1	38		
			"	11.4	27.1	28		
		"	11.6	27.9	38			
22/2/90	Wongungarra R. 8323/005926 (1)	IBP	Not Collected				16.5	
22/12/90	Betka R. 8822/222434 (10)	CBW	Not Collected					
1/3/90	Yalmy R. 8523/276597 (3)	FS	D66040	12.4	28.3	39		<i>L. lesueuri</i> <i>L. citropa</i> <i>R. signifera</i>
			"	12.9	32.4	40		
			"	12.9	22.4	41		
			"	12.2	30.3	39		
		"	10.9	15.4	40			
8/1/91	Cann R. East Br. 8723/919818 (6)	CBW	D66039	11.5	28.3	40		<i>L. lesueuri</i> <i>L. citropa</i> <i>R. signifera</i>
			"	10.1	23.8	37		
			"	10.5	25.2	38		
			"	13.0	29.3	40		
			"	11.4	27.5	39		
21/1/91	Hard to Seek Ck 8822/256361 (7)	CBW	D66037	8.0	18.4	30		<i>L. peroni</i> <i>L. lesueuri</i>
			"	9.2	21.5	35		
			"	10.6	26.3	37		
			"	8.2	19.7	30		
			"	10.1	10.1	47		
15/2/91	Martins Ck 8623/424613 (4)	CBW	D66041	11.5	26.1	39		<i>L. lesueuri</i>
			"	11.5	26.4	38		
			"	11.5	27.6	39		
			"	10.9	25.6	39		
			"	11.6	27.1	39		
		FS	"	11.8	25.3	38		
			"	11.2	25.8	38		
			"	11.1	24.5	37		
			"	12.1	27.6	39		
			"	11.0	23.9	37		

Date	Location & Aust. Map Grid	Micro-habitat	Museum Reg. No.	BL mm	TL mm	Gosner Stage	Water °C	Sympatric Species
26/2/91	Sardine Ck 8522/280450 (5)	FS	D66042	8.6	18.8	32		<i>L. lesueuri</i>
			"	11.9	23.7	37	<i>L. citropa</i>	
			"	11.8	31.4	41	<i>R. signifera</i>	
			"	10.5	25.2	36		
			"	12.2	28.4	37		
28/1/92	Sardine Ck 8622/356482 (5)	FS	D66043	11.2	25.5	31		<i>L. citropa</i>
			"	11.4	26.5	36	<i>L. lesueuri</i>	
			"	9.1	19.1	30		
			"	11.4	25.3	36		
			"	10.7	22.7	36		
11/3/91	Little Yalmy R. 8523/313612 (2)	FS	D66038	12.2	27.3	38		
			"	12.2	27.2	39		
			"	12.0	27.5	39		
			"	13.0	32.1	40		
			"	13.0	32.4	40		
12/1/92	Thurra R. 8723/035497 (7)	CSP	D66036	12.0	25.8	36		<i>L. citropa</i>
			"	10.9	26.4	36	<i>L. lesueuri</i>	
			"	11.7	26.4	36		
			"	9.4	21.3	31		
			"	10.2	20.9	31		
			"	11.6	27.0	35		
			"	9.2	9.8	46		
20/3/92	Maramingo Ck 8823/327586 (8)	CSP	D66044	14.0	32.8	38		
			"	13.5	33.3	41		
			"	13.2	31.0	37		
			"	12.9	30.3	41		
			"	12.6	31.5	38		

Table 1. Localities, habitats, collection dates, measurements and Museum of Victoria registration numbers for tadpoles of *Litoria phyllochroa* examined in this study. Abbreviations for habitats are: CSP = connected streamside pool, ISP = isolated streamside pool, CBW = connected back-water of main stream, IBW = isolated back-water of main stream, IBP = isolated bedrock pool, FS = flowing stream. BL = body length, TL = total length. Numbers in parentheses refer to localities in Fig. 1.

the stream and surrounding vegetation also was made. Observations of tadpoles and activity of adult *L. phyllochroa* were made at additional sites in East Gippsland between October 1989 and January 1992.

Collected tadpoles were identified by growing them to metamorphosis. A series of tadpoles from each site was preserved in 10% formalin. Measurements of body and tail length were recorded using vernier callipers measuring to the nearest 0.1 mm (Table 1). Material examined has been lodged in the Museum of Victoria, Melbourne (NMV).

Descriptions of tadpoles were made by observation under a binocular dissecting microscope. Terminology follows Altig (1970) and Hero (1990). Developmental stages are those of

Gosner (1960). A single representative specimen (stage 37, NMV D61727) was illustrated by tracing from photographs. The labial tooth row formula (LTRF) illustrated is based on observations of several specimens at stages 25 to 42. The drawings depict melanic patterns that persist in preserved specimens (10% formalin). Habitat and life history notes also are presented to assist identification, but these are intended as a guide only and tadpoles could be found in different habitats and seasons than those given. Caution should be taken with descriptions of colour, as colour is often a function of water clarity (Bragg 1957).

Comparisons with tadpoles of other lotic species were made from descriptions in the literature and from specimens of *L. citropa*, *L.*

lesueuri and *L. spenceri* tadpoles collected during this study (Table 2). Measurements of body length and oral disc width of eight *L. spenceri* specimens were made with vernier callipers and compared with those of eight *L. phyllochroa* tadpoles at similar Gosner stages, using Student's *t* test.

RESULTS AND DISCUSSION

Description of tadpole (stage 37)

The anus is dextral and the spiracle sinistral. The body is elongated and flattened. The tail is moderately thick, has a rounded tip and is deepest in the anterior half. Neuromast pores are visible along the body and anterior section of the tail. The lateral lines may be heavily pigmented along part of their length and interspersed with unpigmented sections, but this varies considerably between individuals. Eyes are dorsolateral and the mouth is ventral. The nares are dorsal in position and directed anterolaterally. They are slightly closer to the tip of the snout than to the eyes, and spaced more closely than the eyes.

The mouth is ventral. The oral papillae have a wide anterior gap. Submarginal papillae are present beside the posterior and lateral oral papillae (Fig. 2). There are two rows of labial teeth in the anterior labium and three in the posterior labium. Median gaps are present in the second anterior and the first posterior tooth rows (Fig. 2). When preserved, the second anterior tooth rows commonly overlap at the middle.

The body is dark brown above with scattered fine silver chromatophores. The orbital and narial regions are paler with less uniform pig-

mentation. Large irregularly-shaped golden flecks are visible in live specimens on the flanks and extending onto the margins of the grey ventral surface. These melanophores turn black in preserved specimens. A few scattered melanophores are present on the venter of some individuals, where the intestine is visible. At later stages of development (> Gosner 35) dark spots may be present on the dorsal surface and may persist in preserved specimens. The tail muscle is pale with scattered melanophores forming small clumps or striations, with larger clumps along the dorsal edge. The fins are transparent with scattered melanophores, often in small clumps, becoming less numerous ventrally and anteriorly.

Tadpoles vary in total length from 12.7 mm at stage 25 to a maximum size recorded of 33.3 mm at stage 41 (Table 1). Snout-vent measurements taken of two newly metamorphosed individuals in the field and five reared in captivity ranged from 10.5 mm to 14.1 mm. Newly metamorphosed individuals are grey-brown with no green markings; the pale lateral zone typical of adults is visible. Captive individuals developed green pigmentation seven to fourteen days after metamorphosis.

Comparison

The tadpole of *L. phyllochroa* is morphologically similar to other described tadpoles of the *L. citropa* complex, including those of *L. spenceri*. It could also be confused with *L. lesueuri* in the field. Examination of the mouth parts of preserved specimens clearly distinguishes *L. lesueuri* and *L. citropa* from *L. phyllochroa*, *L.*

Species	No. Individ.	Date	Aust. Map Grid	Museum Reg. No.
<i>L. citropa</i>	1	23/3/92	8823/281521	D66029
<i>L. citropa</i>	8	8/1/91	8723/898705	D66030
<i>L. citropa</i>	5	9/1/91	8622/356479	D66031
<i>L. citropa</i>	3	8/1/91	8723/919818	D66032
<i>L. citropa</i>	3	12/1/91	8723/035479	D66033
<i>L. citropa</i>	11	21/1/92	8822/256361	D66034
<i>L. citropa</i>	1	28/1/92	8622/356482	D66035
<i>L. lesueuri</i>	1	28/1/92	8622/356482	D66045
<i>L. lesueuri</i>	2	23/6/91	8523/156510	D66046
<i>L. lesueuri</i>	1	22/1/92	8822/223434	D66047
<i>L. spenceri</i>	1	25/2/92	8123/153622	D66048
<i>L. spenceri</i>	2	23/2/92	8122/385473	D66049
<i>L. spenceri</i>	3	10/3/92	8324/346276	D66050
<i>L. spenceri</i>	5	5/3/92	8324/339292	D66051

Table 2. Localities and Museum of Victoria registration numbers for tadpoles of *Litoria citropa*, *L. lesueuri* and *L. spenceri* examined in this study.

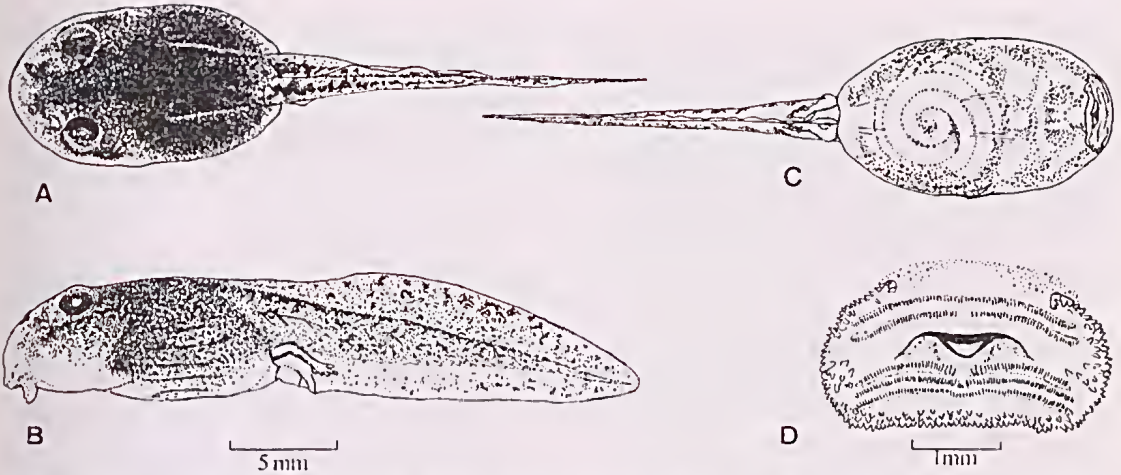


Fig. 2. *Litoria phyllochroa* tadpole (NMV D61727, stage 37). A, dorsal view. B, lateral view. C, ventral view. D, oral disc.

pearsoniana and *L. spenceri*. The first two species have a complete papillary border whilst the last three have a wide anterior gap in the oral papillae (Hero et al. in prep., McDonald & Davies 1990). *L. subglandulosa* is distinguished from all of the above species by the possession of a specialized mouth which contains no tooth rows and a small unpigmented beak (Tyler & Anstis 1975).

In life *L. lesueuri* is distinguished from species of the *L. citropa* complex by the large oral disc, yellowish tail fins with either no pigmentation or a few scattered chromatophores (personal observation), heavily pigmented tail muscle (Martin et al. 1966) and gold venter. *L. phyllochroa* has

dark pigment scattered over the dorsal and ventral tail fins and a transparent venter. *L. citropa* may be distinguished from *L. phyllochroa* by the strong banding in the tail muscle pigmentation (Tyler & Anstis 1975) and by the presence of patches of dark pigmentation scattered over the tail fins.

The only described character of the tadpole of *L. pearsoniana* which appears to distinguish it from *L. phyllochroa* is the depth of the fin. McDonald & Davies (1990) noted that the fin of *L. pearsoniana* is deepest posteriorly, whereas in all specimens of *L. phyllochroa* examined during the present study the fin was deepest anterior to the midpoint of the tail.

Key to tadpoles of presently described species of the *L. citropa* complex and other lotic hylid tadpoles in Victoria

* = Ratio of body length to oral disc width

- 1. Tooth rows present 2
- Tooth rows absent *L. subglandulosa*
- 2. Complete papillary border 3
- Wide anterior gap in papillary border 4
- 3. Heavily pigmented banding of tail muscle but little or no pigmentation in fins. Heavily pigmented venter obscuring intestine *L. lesueuri*
- Melanie clumps in fins, intestine clearly visible through venter *L. citropa*
- 4. Fin deepest anterior to midpoint of tail 5
- Fin deepest posteriorly *L. pearsoniana*
- 5. Small oral disc (BL/ODW > 3.8*) . Clear venter *L. phyllochroa*
- Large oral disc (BL/ODW < 3.8*) . Dark pigmentation extending onto venter, partially obscuring intestine *L. spenceri*

Comparison of oral disc width to body length ratios of preserved *L. spenceri* and *L. phyllochroa* tadpoles indicates that *L. spenceri* has a significantly wider oral disc ($t = 7.426$, $P < 0.005$; Table 3). In addition, the oral disc of *L. spenceri* is darkly pigmented and has thicker papillae. Preserved specimens of *L. phyllochroa* have few melanophores on the venter and the intestine is clearly visible, whilst the intestine of *L. spenceri* is largely obscured by dark melanophores (Hero et al. in prep.). This distinction is not visible in life as both species appear to have a transparent venter. However, the absence of large golden flecks on the flanks of *L. spenceri* tadpoles is a distinction from *L. phyllochroa* and assists identification in the field.

Habitat

Litoria phyllochroa tadpoles were found in a variety of micro-habitats in eastern Victoria (Table 1) including isolated and connected streamside pools, the main channel of streams, along shingle banks and in large back-waters. Tadpoles were often found in different situations along the one stream. For example, on the Wongungarra River tadpoles were found in isolated and connected streamside pools on shingle banks, in large back-waters of the river and in the main stream. Along Sardine Creek, tadpoles were found at one location in cattle hoof prints along a sand bar. Substrate included rock, gravel, fine sand and rotting litter. Tadpoles were most frequently found in the quieter sections of streams, such as deep pools, or amongst pebbles along shingle banks. Tadpoles were generally found on the bottom, either on rocks or amongst litter where they appeared to be feeding on an accumulated mixture of silt, detritus and algae.

	<i>L. phyllochroa</i>	<i>L. spenceri</i>
	3.9	3.1
	4.0	3.2
	4.0	3.2
	4.3	3.4
	4.3	3.5
	4.4	3.5
	4.4	3.5
	4.5	3.7
mean	4.2	3.4
SD	0.23	0.20

Table 3. Body length to oral disc width ratios for samples of *Litoria phyllochroa* and *L. spenceri* tadpoles between Gosner stages 33 and 38.

Fine grains of sand are clearly visible in the intestines of preserved specimens.

Collection sites ranged in altitude from near sea level on Hard To Seek Creek to 700–800 m along the Wongungarra River. The calibre of stream varied markedly, from small, slow-flowing creeks, such as Martins Creek, to major rivers with heavy flows, such as the Wongungarra and Yalmy rivers.

Tadpoles were found along streams flowing through a range of vegetation communities. These included warm temperate rainforest (Thurra River) and *Tristaniopsis laurina*-dominated riparian forest (Sardine Creek), riparian scrub-heathland dominated by *Melaleuca squarrosa* (Hard To Seek Creek), and a range of open eucalypt forest communities, including dry sclerophyll and wet sclerophyll forests (Cann River and Martins Creek respectively).

At a number of sites fish (salmonid or galaxiid species) were observed swimming among *L. phyllochroa* tadpoles. Salmonid species are present in all of the stream systems in which *L. phyllochroa* was found, except the Betka River and Hard To Seed Creek (Raadik in prep.). Tadpoles were recorded in the main channels of both of the latter streams which are known to include twelve species of native fish in their catchments (Raadik in prep.). This suggests that *L. phyllochroa* tadpoles have mechanisms for defence against predation by both native fish and introduced salmonid species.

Sympatry

Five other species of tadpoles were found along streams at the same time as *L. phyllochroa* tadpoles were collected, namely *L. citropa*, *L. lesueuri*, *L. peroni*, *L. spenceri* and *Ranidella signifera*. With the exception of the Little Yalmy River and Maramingo Creek, *L. lesueuri* tadpoles were found at all locations, both in syntopy (i.e. in the same waterbody) and in sympatry (different waterbody, same section of river). *Litoria citropa* tadpoles were found in both syntopy and sympatry with those of *L. phyllochroa* and *L. lesueuri* in Sardine Creek and in the Cann and Yalmy rivers. *Litoria peroni* tadpoles were found in syntopy with *L. phyllochroa* only in Hard To Seek Creek. *L. peroni* usually utilizes stationary water bodies for reproduction (personal observation) and is not considered a lotic species in this study. *Litoria spenceri* tadpoles were only found in sympatry with *L. phyllochroa* on the Wongungarra River, but metamorphling *L. phyllochroa*, *L. spenceri* and *L. lesueuri* have

been found together on Snowy Creek, north-east Victoria (G. Johnson pers. comm., Department of Conservation & Environment, Wodonga, Victoria). Tadpoles of *Ranidella signifera* were found in sympatry with those of *L. phyllochroa* on the Cann, Betka and Yalmy rivers and on Sardine Creek.

Breeding activity

The breeding activity and stream habitats used by *L. phyllochroa* are generally similar to those of other species within the *L. citropa* complex and appear to parallel closely those of *L. pearsoniana* (Tyler & Anstis 1975, McDonald & Davies 1990).

In 1989/1990 and 1990/1991 males were heard calling in East Gippsland between early October and February. In 1991 and 1992 males were heard calling at one location as late as mid-April and as early as mid-September. Males are regularly heard calling during the day, although calling is more intense in the evenings. Calling activity is most intense in October and November, during or after rain. Males were most frequently observed calling from grass and *Lomandra longifolia* tussocks adjacent to the stream and from small over-hanging branches or fern fronds up to 2.5 m above the stream.

Tadpoles were encountered in mid-December at stages 25–29 (Table 1). Newly metamorphosed individuals were recorded between mid-February and late March. However, tadpoles at stages 30–40 were also observed in some streams in late March. Given a peak in breeding activity in October/November and the presence of tadpoles in late March, larval development may take between three and six months.

Adult behaviour

Litoria phyllochroa is active both during the day and at night. In January 1991 several individuals were found hopping amongst ground ferns in warm temperate rainforest along Martins Creek (dry temperature 20°C) and in a grassy clearing at mid-day (dry temperature 26°C). Individuals were also observed basking on small branches over the Yalmy River, Thurra River and Maramingo Creek (dry temperature 16–24°C). These individuals had taken on dark olive and almost black colorations.

In spring and summer adult male frogs were found sheltering near the banks of streams under rocks and amongst dense ground vegetation. In March and April several individuals were col-

lected from amongst leaf and bark litter at the bases of large trees in damp sclerophyll forest at sites up to 200 m from the stream.

Litoria phyllochroa exhibits some activity during the winter period. In July 1991, 12 individuals were found perched on small branches, *Gahnia* spp. and fern fronds in warm temperate rainforest along the Thurra River at night (temperature 8°C, 100% humidity).

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